To obtain a fuller scope of coverage, new claims 27-31 have been added. Adequate support for the subject matter recited in these claims may be found in the specification as originally filed.

Early and favorable action on the merits are respectfully requested.

Respectfully submitted,

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MAILING CERTIFICATE

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Signature

June 10, 2003
Date

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION:

Paragraph beginning at line 3 of page 1 has been amended as follows:

The present invention relates to an image reading apparatus in which a synthesized whole image is obtained from partial images through detection of a relative moving amount of the object of reading and the image reading apparatus, whereby it is possible to read an object [of reading] having protrusions and recesses like a fingerprint and a planar object [of reading] having light and shade portions like an original document.

Paragraph beginning at line 15 of page 1 has been amended as follows:

The image reading apparatus for reading fingerprints shown in Fig. 18 utilizes differences in reflected light due to the differences in state of contact between the crests and troughs of a fingerprint when the tip of a finger is applied to an optical member having a transparent input surface like a glass plate. That is, when a finger [1077] 107 is applied to an input surface of a prism array 101 consisting of glass, synthetic resin or the like and serving as an input member,

the crests of the skin are in contact with the input surface of the prism array, whereas the troughs of the skin are in contact with air. Thus, when the incidence angle becomes close to the critical angle at the interface between the prism array and the air, the reflectance becomes relatively high in the troughs, with the result that there is generated a large difference in reflectance between the crests and troughs, and the crests and troughs of the fingerprint are read as a light-dark pattern.

Paragraph beginning at line 11 of page 2 has been amended as follows:

Further, an example of an image reading apparatus having a light detecting means and adapted to read fingerprints and [originals] original documents by synthesizing a two-dimensional whole image from partial images through relative movement of the object [of reading] being read and the image reading apparatus is disclosed in Japanese Patent Application Laid-Open No. 10-240906, according to which illumination light is caused to imagine vertically upon the input surface to detect vertical reflected light.

Paragraph beginning at line 4 of page 4 has been amended as follows:

To achieve the above object, there is provided in accordance with [Claim 1 of] the present invention an image reading apparatus comprising a light source, an input member having an input surface for reading an object [of reading], and a light detecting means composed of a plurality of photoelectric conversion elements for detecting light scattered or reflected at an interface between the object [of reading] and the input surface,

wherein the input member consists of a transparent base member and is formed by a rotary member rotating in accordance with an amount of relative movement between the object [of reading] and the image reading apparatus,

the apparatus further comprising a whole image synthesizing means which detects a rotating amount of a first rotary member by a first light detecting means to detect an amount of relative movement between the object [of reading] and the image reading apparatus and which obtains a whole image of the object [of reading] on the basis of a partial image obtained by the first light detecting means and the movement amount.

Paragraph beginning at line 22 of page 4 has been amended as follows:

In accordance with another object [Claim 2] of the invention, there is provided an image reading apparatus according to the above aspect [Claim 1], wherein a light-dark pattern is formed on a surface at one end of the first rotary member, and wherein the first light detecting means detects light emitted from a first light source and transmitted through the light-dark pattern to thereby detect a rotating amount of the first rotary member.

Paragraph beginning at line 6 of page 5 has been amended as follows:

In accordance with another aspect [Claim 3] of the invention, there is provided an image reading apparatus according to the foregoing aspects [Claim 1 or 2], wherein the first light detecting means is at a position where it receives reflected light generated from the interface between the object of reading and the input surface and determined by Snell's law.

Paragraph beginning at line 11 of page 5 has been amended as follows:

In accordance with still another aspect [Claim 4] of the invention, there is provided an image reading apparatus

according to the foregoing aspects [Claim 1 or 2], wherein the first light detecting means is at a position where it receives reflected light generated from the interface between the object of reading and the input surface and determined by Snell's law and scattered light generated from the interface between the input surface of the first rotary member and the object [of reading].

Paragraph beginning at line 18 of page 5 has been amended as follows:

In accordance with yet another aspect [Claim 5] of the invention, there is provided an image reading apparatus according to the foregoing aspects [Claim 1 through 4], wherein incident light emitted from the first light source and incident on the input surface has a plurality of different incidence angle components.

Paragraph beginning at line 23 of page 5 has been amended as follows:

In accordance with still yet another aspect [Claim 6] of the invention, there is provided an image reading apparatus according to one of the foregoing aspects [Claims 1 through 5], wherein there is provided one of an image formation optical system and a mirror between optical paths of the first rotary member and the first light detecting means.

Paragraph beginning at line 4 of page 6 has been amended as follows:

In accordance with another aspect [Claim 7] of the invention, there is provided an image reading apparatus according to one of the foregoing aspects [Claims 1 through 5], wherein there is provided an optical fiber bundle between the optical paths of the first rotary member and the first light detecting means.

Paragraph beginning at line 9 of page 6 has been amended as follows:

In accordance with another aspect [Claim 8] of the invention, there is provided an image reading apparatus according to one of the foregoing aspects [Claims 1 through 7], wherein the first rotary member and the image formation optical system are formed of a glass base material which is an inorganic base material or a synthetic resin which is an organic base material.

Paragraph beginning at line 14 of page 6 has been amended as follows:

In accordance with a further aspect [Claim 9] of the invention, there is provided an image reading apparatus according to one of the foregoing aspects [Claims 1 through

8], wherein there is provided on the input surface of the first rotary member a dirt prevention layer adapted to prevent dirt from adhering to the surface.

Paragraph beginning at line 19 of page 6 has been amended as follows:

In accordance with still a further aspect [Claim 10] of the invention, there is provided an image reading apparatus according to one of the foregoing aspects [Claims 1 through 9], wherein there is provided a cleaner adapted to remove dirt adhering to the surface of the first rotary member.

Paragraph beginning at line 23 of page 6 has been amended as follows:

In accordance with still yet a further aspect [Claim 11] of the invention, there is provided an image reading apparatus according to one of the foregoing aspects [Claims 1 through 10], wherein the object [of reading] includes an object [of] [reading] having protrusions and recesses like a fingerprint and an object [of reading] having light and shade like an original document.

Paragraph beginning at line 4 of page 7 has been amended as follows:

In accordance with a still yet further aspect [Claim 12] of the invention, there is provided an image reading apparatus according to one of the foregoing aspects [Claims 1 through 10], wherein there is provided a function by which a one-dimensional position input is effected in accordance with the rotating amount of the first rotary member.

Paragraph beginning at line 9 of page 7 has been amended as follows:

In accordance with an additional aspect [Claim 13] of the invention, there is provided an image reading apparatus according to one of the foregoing aspects [Claims 1 through 10], further comprising a second rotary member having a rotation axis different from the rotation axis of the first rotary member and a means for detecting a rotating amount of the second rotary member, wherein there is provided a function by which a two-dimensional position input is effected in accordance with the rotating amount of the first rotary member and that of the second rotary member.

Paragraph beginning at line 17 of page 7 has been amended as follows:

In accordance with another additional aspect [Claim 14] of the invention, there is provided an image reading apparatus according to one of the foregoing aspects [Claims 1 through 10], further comprising a second rotary member which has a rotation axis different from the rotation axis of the first rotary member and on the surface of one end portion of which a light-dark pattern is formed, a second light source, a second light detecting means, and a rotating amount detecting means for detecting a rotating amount of the second rotary member by detecting light emitted from the second light source and transmitted through the light-dark pattern formed on the surface of the second rotary member, wherein there is provided a function by which a two-dimensional position input is effected in accordance with the rotating amount of the first rotary member and that of the second rotary member.

Paragraph beginning at line 8 of page 8 has been amended as follows:

Fig. 1 is a sectional view showing main components of an image reading apparatus according to an embodiment of the present invention; Fig. 2 is a sectional view showing main

components of an image reading apparatus according to an embodiment of the present invention; Fig. 3 is a perspective view showing a rotary member and a light-dark pattern; Fig. 4 is a sectional view illustrating the positional relationship between a light-dark pattern, incident light, and reflected light; [Fig. 5 is a diagram] Figs. 5A and 5B are diagrams showing the relationship between a light-dark pattern and the output of a light detecting means; Fig. 6 is a sectional view showing the relationship between the refractive index and incidence-angle/reflectance characteristics; Figs. 8A and 8B are [Fig. 8 is a] section [view] views showing the relationship between incident light, reflected light, and scattered light; Figs. 9A and 9B are [Fig. 9 is a] sectional [view] views of an image reading apparatus according to an embodiment of the present invention which is capable of reading both a fingerprint and an original; [Fig.] Figs. 10A and 10B are [is a] sectional [view] views of an image reading apparatus according to an embodiment of the present invention which is capable of reading both a fingerprint and an original; [Fig.] Figs. 11A and 11B are [is a] sectional [view] views of an image reading apparatus according to an embodiment of the present invention which is capable of reading both a fingerprint and an original; Figs. 12A and 12B are [Fig. 12 is a] sectional [view] views showing an image reading apparatus

according to an embodiment of the present invention; Fig. 13 is a sectional view showing an image reading apparatus according to an embodiment of the present invention; Fig. 14 is a sectional view showing an image reading apparatus according to an embodiment of the present invention; Fig. 15 is a perspective view showing an image-reading/input apparatus according to an embodiment of the present invention, [Fig.] Figs. 16A and 16B are[is a schematic] [diagram] diagrams showing a mobile phone in which an image-reading/input apparatus according to an embodiment of the present invention is mounted; Fig. 17 is a schematic diagram showing a mouse in which an image-reading/input apparatus according to an embodiment of the present invention is mounted; Fig. 18 is a sectional view showing a conventional image reading apparatus; and Fig. 19 is a sectional view showing a conventional image reading apparatus.

Paragraph beginning at line 3 of page 12 has been amended as follows:

[Fig. 5 shows] Figs. 5A and 5B show the relationship between the light-dark pattern and the output of the light detecting means. In comparison with the strip-like light-dark pattern shown in Fig. 5A, the triangular light-dark pattern shown in Fig. 5B is more advantageous in that it allows the

rotating direction to be detected easily and that it makes it possible to achieve higher resolution for the same cycle of the light-dark pattern. In this way, in the image reading apparatus of the present invention, a partial image is detected and, at the same time, the rotating amount of the rotary member is detected, so that even if the finger movement is not smooth, it is possible to synthesize a whole image relatively easily. While in the method of detecting the rotating amount of the rotary member shown in Fig. 3 a light-dark pattern is formed at one end of the rotary member and the rotating amount is detected through variation in the amount of light transmitted through the light-dark pattern, the method of detecting the rotating amount of the rotary member in the present invention is not restricted to this method. For example, it is also possible to use a separate rotary member adapted to rotate in synchronism with the rotary member that is into contact with the finger, detecting the rotating amount of the separate rotary member by the light detecting means.

Paragraph beginning at line 24 of page 12 has been amended as follows:

Next, the basic principle of reading a partial image of a fingerprint and an original by the image reading apparatus of the present invention will be described in detail

with reference to Figs. 6 through 8. In the following description [present invention], the term "reflected light" means a reflected light which follows Snell's law at the interface of the input surface of the rotary member, and the term "scattered light" means a light which is transmitted through the input member and reflected by the finger skin or the original, or the interface of the air and the skin or the interface of the original and the air before returning to the input surface side of the rotary member.

Paragraph beginning at line 7 of page 14 has been amended as follows:

Reflectance curve [9] 10 indicates the reflectance when the refractive index of the rotary member is 1.5, and reflectance curve 11 [10] indicates the reflectance when the refractive index of the rotary member is 2, the rotary member being in contact with the air in each case. Reflectance curve 12 [11] indicate the reflectance when the refractive index of the rotary member is 2, with the rotary member being in contact with the skin.

Paragraph beginning at line 23 of page 14 has been amended as follows:

Figs. 8A and 8A are [Fig. 8 is a] [diagram] diagrams showing the condition of the incident light, reflected light,

and scattered light when a fingerprint is read and when an original is read. Fig. 8A shows the incident light and reflected light when a fingerprint is read. In this way, when the incident light has an illuminance of a value not lower than a fixed value, with the incidence angle being not larger than the critical angle and not smaller than 20 degrees, the contrast at the input surface of the reflected light from the troughs and the crests of the fingerprint is higher than when light is incident and reflected vertically.

Paragraph beginning at line 12 of page 16 has been amended as follows:

[Fig. 9 shows] Figs. 9A and 9B show an image reading apparatus having two light sources. [Fig. 10 shows] Figs. 10A and 10B show an image reading apparatus having a planar light source capable of switching the light emission area like an EL. [Fig. 11 shows] Figs. 11A and 11B show an image reading apparatus having a light detecting means with a large light reception area.

Paragraph beginning at line 1 of page 18 has been amended as follows:

In the embodiment shown in Figs. 12A and 12B [Fig. 12], there is provided between the first rotary member 3 and the light detecting means 5 an image formation optical system

composed of a mirror 17, an optical lens 18, and a field stop 19, whereby it is possible to correct image distortion and to achieve a reduction in the size of the light detecting means and the entire apparatus. While in the image reading apparatus shown in [Fig.] Figs. 12A and 12B an equivalence optical system is used with respect to the axial direction of the rotary member, the present invention is also applicable to an image reading apparatus using a reduction optical system with respect to the axial direction of the rotary member.

Paragraph beginning at line 8 of page 20 has been amended as follows:

[Fig. 16 shows] Figs. 16A and 16B show a mobile phone containing an image reading apparatus according to the present invention. An image reading apparatus as shown in Fig. 15 is mounted in the mobile phone, and further a software package needed for the identification of a fingerprint, etc. are mounted, whereby it is possible to realize an apparatus which is compact and inexpensive and provided with a fingerprint identifying function, cursor input function, etc.